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BIOLOGICAL BULLETIN

THE OVOGENESIS OF HYDRA FUSCA — A PRELIMINARY PAPER.

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Kleinenberg in his thesis on hydra, 1872, maintained the following twelve points in regard to the formation of the ovary and the growth of the egg :

1. The ovary is formed by a rapid multiplication of the interstitial cells at the site of the ovary.

2. There is evidence in the relative infrequency of the interstitial cells, in the territory about the forming ovary, that their accumulation may be, in part, due to migration, though he has no direct evidence of this.

3. The interstitial cells at the center of the ovary are larger than those at the margin.

4. The interstitial cells are arranged in rows converging toward the center of the ovary.

5. The egg appears in the midst of the cells of the ovary where it has likely lain, indistinguishable from the interstitials.

6. It now comes to be distinct because of its rapidly increasing size and its irregular contour.

7. Later it becomes amœboid.

8. In the early stages of the egg granules appear in its substance which are equivalent to the white of the egg (protagon) of the eggs of higher forms.

9. These disappear and then the egg gradually fills up with the so-called "Pseudozellen" or yolk granules.

10. The cells about the egg in the ovary disintegrate to form nutritive material for the egg.

11. The egg thus increases greatly in size and with the mass of interstitials about it, greatly distends the ectoderm cells which elongate into fibers and are crowded to one side.

12. The egg breaks through these restraining ectoderm cells which are transformed into lamellæ at their peripheral end but are still connected with the muscle layer of the mesogloea.

13. Brauer¹ describes the newly extruded egg as spherical, except for a stalk which attaches the egg to the parent. There is, too, a conical depression in the peripheral layer of the egg which layer is free from yolk. This depression lies opposite the attaching stalk over the nucleus, and by it the sperm has access.

14. Brauer states that the hydra egg gives off two polar bodies.

In attempting to confirm these results on sections of hydra prepared while working on another hydra problem, evidence accumulated that seemed to contradict some of these results. Additional material now convinces me that some of these statements are incorrect for *H. fusca* and permits me also to settle some additional points, notably on the chemical nature and the exact method of the inclusion of the yolk.

1. The multiplication of interstitial cells at the site of the ovary is by mitosis, twelve chromosomes appearing in the figure.

2. The interstitials are no less frequent immediately about the ovary than elsewhere, so there is no evidence of their migration into the region of the ovary.

3. The cells at the center of the ovary are larger than those at the margin, as Kleinenberg states. My measurements show that the central cells average four times, or a trifle more, the volume of the marginal. It is to be remembered that these central cells are adjacent to the growing eggs. The influences causing growth seem to operate on the whole region.

4. Kleinenberg, working largely on *H. viridis*, and later authors, notably R. Hertwig, working on *H. fusca*, claim that the egg appears only after the ovary has achieved considerable size. My sections seem to force the conclusion, however, that the egg is always present, before proliferation of the interstitials begins to form the ovary. The egg is often, and so far as I can see always, growing rapidly before the interstitials begin to multiply. It

¹ *Zeit. f. wiss. Zool.*, V., 52, pp. 167-216.

looks, therefore, as if the increase in size of the egg or eggs might be the cause or at least the occasion of the multiplication of these interstitial cells.

5. R. Hertwig¹ and others, maintain that the egg is merely an interstitial cell which, after the ovary has begun to grow, increases in size more rapidly than its fellows. The egg seems in my sections always recognizable as such in the adult hydra. It is slightly larger than the inactive interstitials, has a very large nucleus in proportion to the cell body, adjacent to which there lies in this early stage a small dark ovoid body. The cell outline is spherical, whereas the resting interstitials are polygonal in section. There often appears at the early stage and always a little later, as Kleinenberg pointed out, a vacuole near the nucleus. All gradations from the large undoubted egg to this cell are readily found. But intermediates between it and the interstitials are, I may not yet say, wanting, but certainly rare. The evidence seems to point then to distinct germ cells in the adult hydra.

6. My results, furthermore, disagree with Kleinenberg's interpretation of the nutrition of the egg and extend the observations on the origin of the yolk granules as follows: At first the egg is nourished as are the adjacent ectoderm and interstitial cells. Material absorbed by the endoderm cells is massed in spherules filled with brown droplets, perhaps granules. This is apparently transformed, in large measure, in the endoderm cells and passed to the ectoderm, as this brown material seldom appears in the ectoderm cells. The endoderm cells elaborate also a material which stains deeply with osmic acid. This is also passed to the ectoderm, the cells of which are more heavily laden with it than are the endoderm cells. It passes into the egg and interstitial cells as well as others. The usual lecithin tests show it to be that substance or a closely related one. The egg at first contains the lecithin diffuse, but later in granular masses, "Pseudozellen." The interstitial cells also absorb it and the nuclei become filled with it, meantime enlarging considerably. Those interstitial cells adjacent to the egg in the fairly mature ovary have their walls in contact with the egg resorbed and the content of the cell becomes

¹ "Über Knospung und Geschlechtsentwicklung von *H. fusca*," *Biol. Centralbl.*, Vol. 26, 1906.

part of the egg (Nussbaum). The greatly enlarged nuclei, gorged with lecithin, also become yolk granules or "Pseudozellen."

7. Two polar bodies are extruded by the egg, as other observers have noted. The material thus far examined will not permit a final statement as to the details of reduction, but the first polar body contains twelve chromosomes, the second six. Certainly the female pronucleus has six, as has the male pronucleus also.

8. The nucleus and chromosomes though varying greatly in size are constantly present, never disintegrating and disappearing.